

1 **WATER-SOLUBLE AND NON-WATER-SOLUBLE**
2 **MATERIALS SEPARATION DEVICE**

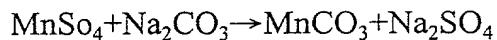
3 BACKGROUND OF THE INVENTION

4 1. Field of the Invention

5 The present invention relates to a separation device, and more particularly to a
6 separation device for separating water-soluble and non-water-soluble materials by
7 repeated precipitation.

8 2. Description of Related Art

9 Products from chemical reactions often are separated into water-soluble and
10 non-water-soluble categories. For example:



12 When solvent MnSO_4 is added with Na_2CO_3 , the product will be MnCO_3 and
13 Na_2SO_4 , wherein the MnCO_3 is non-water-soluble and Na_2SO_4 is water-soluble. In order
14 to separate these two different products, the user often has to repeatedly use the curing
15 process to extract the solution in the upper portion of the reaction tank out of the reaction
16 tank after addition of a chemical material to facilitate the separation of these two
17 different products and after stirring of the solution. When employing this curing method,
18 the user has to wait for at least one day to allow the precipitation to completely sink to
19 the bottom of the reaction tank every time the solution is stirred. Further, during the
20 process, the user will have to add clean water repeatedly so as to lessen the concentration
21 of the solution every time the solution is removed out of the reaction tank. After several
22 times of repeating the same process, the precipitation is obtained. However, the process
23 wastes a lot of water to lessen the concentration, and also the extracted solution is not
24 pure. That is, the retained precipitation still has the water-soluble material and the

1 solution also contains the non-water-soluble material.

2 To overcome the shortcomings, the present invention tends to provide an
3 improved separation device to mitigate and obviate the aforementioned problems.

4 SUMMARY OF THE INVENTION

5 The primary objective of the present invention is to provide a water-soluble and
6 non-water-soluble materials separation device. The device has multiple layers of
7 reaction zones superposed with one another and stirring blades provided in at least one
8 of the reaction zones so as to fully mix the precipitation with the solution. Furthermore,
9 extraction pipes are provided in the reaction zones that have no stirring blades so that
10 after the solution is stirred and urged upwards by the stirring blades, the precipitation
11 flowing into the extraction pipes sinks. After at least one precipitating process in the
12 reaction zones, eventually the precipitation is collected in a collection tank.

13 Other objects, advantages and novel features of the invention will become more
14 apparent from the following detailed description when taken in conjunction with the
15 accompanying drawings.

16 BRIEF DESCRIPTION OF THE DRAWINGS

17 Fig. 1 is a side plan view of the separation device with partial in section;

18 Fig. 2 is a cross sectional view of the separation device by the line 2-2 in Fig. 1;

19 Fig. 3 is a cross sectional view of the separation device by the line 3-3 in Fig. 2;

20 and

21 Fig. 4 is a cross sectional view of the separation device by the line 4-4 in Fig. 2.

22 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

23 With reference to Fig. 1, the water-soluble and non-water-soluble materials
24 separation device is composed of a tank (10) and a conical collection tank (20) provided

1 at a bottom of and communicates an interior of the tank (10).

2 The tank (10) is divided into, from top to bottom, a top precipitation zone (30), a
3 primary stirring zone (32), a primary precipitation tank (34), a secondary stirring zone
4 (36), a bottom precipitation zone (38) and a concentration zone (39) inside the collection
5 tank (20).

6 The top precipitation zone (30) has multiple extraction pipes (300) fully
7 arranged in the top precipitation zone (30) and each having a length 5 to 20 times larger
8 than the diameter of each of the extraction pipes (300). Each extraction pipe (300) is 10
9 to 20 degrees from vertical to the surface level. An outlet (18) is defined in a top portion
10 of the tank (10).

11 Stirring blades (320) are provided in the primary stirring zone (32). An inlet (16)
12 is defined in a side of the tank (10) in the primary stirring zone (32).

13 Second extraction pipes (340) are provided in the primary precipitation zone
14 (34). Each second extraction pipe (340) has a diameter, and a length 5 to 20 times larger
15 than the diameter. Each second extraction pipe (340) is vertical with respect to the
16 surface level of the water.

17 Second stirring blades (360) are provided in the secondary stirring zone (36)
18 which has a water inlet (14) defined in a side of the tank (10) in the secondary stirring
19 zone (36).

20 Like the top precipitation zone (30), the bottom precipitation zone (38) has
21 multiple third extraction pipes (380) each having a length and a diameter 5 to 20 times
22 less than the length and being inclined by 10 to 20 degrees relative to water level.

23 A motor (60) is mounted on top of the tank (10) and has an axle (62) extending
24 from the motor (60) through the top precipitation zone (30), the primary stirring zone

1 (32) and into the secondary stirring zone (36). A first tube (64) is mounted between the
2 top precipitation zone (30) and the primary stirring zone (32), and has the axle (62)
3 extending therethrough. A second tube (641) is mounted between the primary
4 precipitation zone (34) and the secondary stirring zone (36) and has the axle (62)
5 extending therethrough and into the secondary stirring zone (36). With the assistance of
6 the first tube (64), the second tube (641) and the axle (62), the motor (60) is able to drive
7 the stirring blades (320) and the second stirring blade (360) in the primary stirring zone
8 (32) and the secondary stirring zone (36) respectively.

9 With reference to Figs. 2 and 3, a baffle (40) is provided between the top
10 precipitation zone (30) and primary stirring zone (32), the primary stirring zone (32) and
11 the primary precipitation zone (34), the primary precipitation zone (34) and the
12 secondary stirring zone (36) and between the secondary stirring zone (36) and the
13 bottom precipitation zone (38). Each baffle (40) is secured to an inner face of the tank
14 (10) by a positioning plate (42) which is securely engaged with the inner face of the tank
15 (10). Each of the baffles (40) has a central opening (46) aligned with each other to allow
16 the extension of the axle (62), and a tapered periphery (460) formed on a periphery
17 defining the central opening (46). An annular gap (44) is defined between a distal edge
18 of the baffle (40) and the inner face of the tank (10). Further, multiple guiding plates (50)
19 are securely provided on the inner face of the tank (10). It is to be noted that the
20 positioning plate (42) to position the baffle (40) between the top precipitation zone (30)
21 and the primary stirring zone (32) is below the baffle (40) and secured to the inner face
22 of the tank (10). The guiding plate (50) is spatially apart from the baffle (40) between the
23 top precipitation zone (30) and the primary stirring zone (32) and is on top of the baffle
24 (40). The positioning plate (42) to position the baffle (40) between the primary stirring

1 zone (32) and the primary precipitation zone (34) is on top of the baffle (40) and secured
2 to the inner face of the tank (10). The guiding plate (50) is spatially parted from the
3 baffle (40) between the primary stirring zone (32) and the primary precipitation zone (34)
4 and is below the baffle (40). Further, the guiding plate (50), the baffle (40) and the
5 positioning plate (42) among the primary precipitation zone (34), the secondary stirring
6 zone (36) and the bottom precipitation zone (38) are arranged in the same manner.

7 With reference to Figs. 2 and 4, it is seen that the tank (10) may be composed of
8 multiple secondary tanks (10') each having a flange (12) extending outward. With such,
9 when the secondary tanks (10') are assembled, a water proof sealing pad (120) is
10 provided between two adjacent flanges (12) so as to prevent an outflow of liquid
11 contained inside the tank (10) and screws (122) are employed to secure the engagement
12 between two adjacent flanges (12).

13 Before the separation device in accordance with the present invention is in
14 operation, water is added into the tank (10) from the water inlet (14) in the secondary
15 stirring tank (36). Because the outlet (18) is defined in the top portion of the tank (10),
16 continuous addition of water into the tank (10) will force the water to flow upward
17 inside the tank (10). Meanwhile, the material to be separated by the separation device is
18 added into the tank (10) from the inlet (16) in the primary stirring zone (32). The
19 material will be stirred by the stirring blade (320) to fully mix with the water. The
20 solution inside the primary stirring zone (32) and stirred by the stirring blades (320) will
21 be forced to flow laterally by the centrifugal force generated by the stirring such that
22 eventually the solution is forced to flow upward or downward from the annular gap (44)
23 between the primary stirring zone (32) and the top precipitation zone (30) and between
24 the primary stirring zone (32) and the primary precipitation zone (34). Because a width

1 of the guiding plate (50) is larger than a width of the annular gap (44), the solution
2 flowing upward enters the top precipitation zone (30) and is guided by the guiding plate
3 (50) on top of the baffle (40) to flow to a center of the baffle (40). Simultaneously, due to
4 the water inside the tank (10) being constantly flowing upward, the solution in the top
5 precipitation zone (30) enters the first extraction pipes (300) from the bottom thereof.
6 Further, because the length of the extraction pipe (300) is much larger than the diameter
7 of the extraction pipe (300), solution inside the extraction pipe (300) will generate a
8 laminar flow, and because the extraction pipes (300) are inclined relative to the water
9 surface level, precipitation is formed inside the extraction pipes (300). The precipitation
10 inside the extraction pipes (300) will sink to the bottom of the extraction pipes (300) and
11 then is driven by the solution current on top of the baffle (40) to flow to the center of the
12 baffle (40). Therefore, the precipitation will sink to the primary stirring zone (32) from
13 the central opening (46) and along the tapered periphery (460) in the baffle (40). Then
14 clean water flows out of the tank (10) from the outlet (18) due to the upward flowing of
15 the solution inside the tank (10).

16 The solution flowing downward to the primary precipitation zone (34) from the
17 annular gap (44) is guided by the guiding plate (50) below the baffle (40) between the
18 primary stirring zone (32) and the primary precipitation zone (34) to flow toward the
19 center of the baffle (40). However, because the current constantly flows upward, the
20 solution in the primary precipitation zone (34) is forced to enter the primary stirring
21 zone (32). Due to the solution velocity difference between the primary stirring zone (32)
22 and the primary precipitation zone (34), the substance inside the solution entering the
23 primary precipitation zone (34) will precipitate in the second extraction pipes (340) in
24 the primary precipitation zone (34). Moreover, because the flux of water added to the

1 tank (10) is precisely calculated and controlled, the upward velocity of solution is much
2 lower than the downward velocity of the precipitation in the second extraction pipes
3 (340). Therefore, the precipitation effect inside the second extraction pipes (340) will
4 not be affected by the current of the solution outside the second extraction pipes (340).
5 Therefore, precipitation (the non-water-soluble material) will fall on the top face of the
6 baffle (40) below the primary precipitation zone (34). Meantime, the water-soluble
7 material inside the remaining solution is guided to flow out of the second extraction
8 pipes (340) by the upward current and then enter the primary stirring zone (32) from the
9 central opening (46) of the baffle (40) so as to start the previous process all over again.

10 The precipitation (non-water-soluble material) sunk to the secondary stirring
11 zone (36) from the central opening (46) in the baffle (40) between the primary
12 precipitation zone (34) and the secondary stirring zone (36) is stirred by the second
13 stirring blades (360). The stirred solution partly flows upward to the primary
14 precipitation zone (34) from the annular gap (44) and partly flows downward to the
15 bottom precipitation zone (38).

16 The solution flowing to the primary precipitation zone (34) will be guided by
17 the guiding plate (50) between the primary precipitation zone (34) and the secondary
18 stirring zone (36) to flow to the center of the baffle (40), such that the precipitation in the
19 second extraction pipes (340) is also forced to flow to the center of the baffle (40) and
20 eventually falls into the secondary stirring zone (36). The remaining solution is still
21 constantly flowing upward from the second extraction pipes (340).

22 The solution flowing to the bottom precipitation zone (38) is guided by the
23 guiding plate (50) between the secondary stirring zone (36) and the bottom precipitation
24 zone (38) to flow to the center of the baffle (40), such that the precipitation in the third

1 extraction pipes (380) is also forced to flow to the center of the baffle (40) and
2 eventually falls into the concentration zone (39) in the collection tank (20). The
3 remaining solution is still constantly flowing upward from the third extraction pipes
4 (380) to the secondary stirring zone (36). The precipitation concentrated in the
5 concentration zone (39) will be finally collected at a bottom outlet (22) defined in a
6 bottom of the collection tank (20).

7 In order to fully mix the water with the subject to be separated in the separation
8 device of the present invention, the water velocity generated by the stirring blades (320)
9 should be kept 50-1500 times larger than the precipitation speed in the top precipitation
10 zone (30). Because the water velocity requirement in the secondary stirring zone (36) is
11 smaller than that in the primary stirring zone (32), the size of the second stirring blades
12 (360) is smaller than that of the stirring blades (320).

13 Furthermore, in order to smooth the formation of the precipitation, the solution
14 velocity around the annular gap (44) on top and bottom of the primary stirring zone (32)
15 should be kept to be 5-50 times larger than the precipitation speed.

16 The approach required to maintain the solution velocity is to adjust the distance
17 between the guiding plate (50) and the baffle (40) so that the volume of the solution
18 flowing through the annular gap (44) is able to be adjusted. However, the adjustment
19 manner comprises various methods and because they are conventional in the art,
20 detailed description thereof is thus omitted hereinafter.

21 Moreover, the constant upward flow of the solution is controlled by the constant
22 input of water from the water inlet (14) so as to maintain the upward movement of the
23 solution in the tank (10). Besides the input volume of the subject to be separated in the
24 separation device of the present invention is also intensively monitored so as to acquire a

1 complete mix between the water and the subject and to maintain the precipitation speed
2 is always larger than the solution's upward movement.

3 After the solution is repeatedly precipitated consecutively in the tank (10), the
4 water-soluble material and non-water-soluble materials are successfully and effectively
5 separated.

6 It is to be understood, however, that even though numerous characteristics and
7 advantages of the present invention have been set forth in the foregoing description,
8 together with details of the structure and function of the invention, the disclosure is
9 illustrative only, and changes may be made in detail, especially in matters of shape, size,
10 and arrangement of parts within the principles of the invention to the full extent
11 indicated by the broad general meaning of the terms in which the appended claims are
12 expressed.